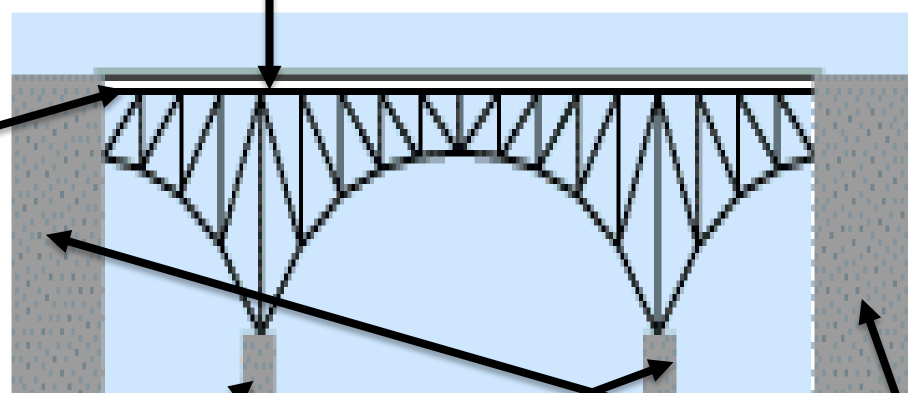
Bridge Basics

Forces & Engineering

Bridge Vocabulary

Deck: the bridge surface on which traffic moves



beam: a horizontal structural element spanning two supports

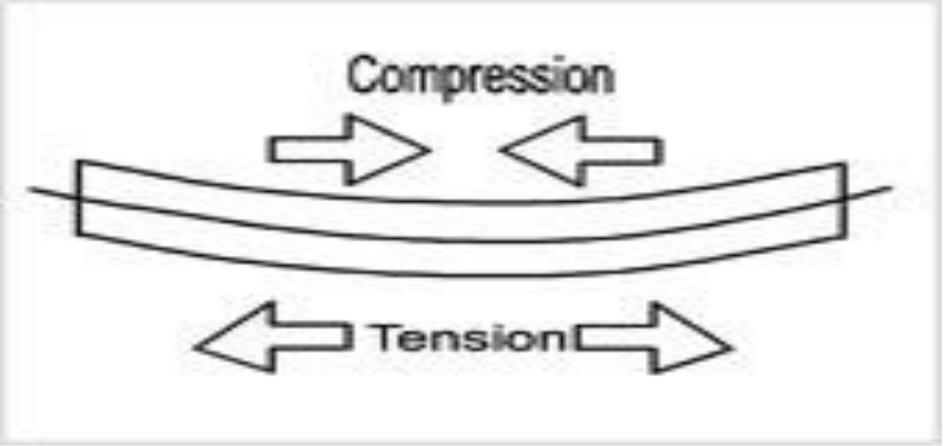
pier: a heavy column or pillar which holds up a bridge

abutments: heavy supports at the ends of a bridge, which transfer the thrust from an arch or strut to the bedrock or earth

Design 1: Beam

- The beam must be able to take the heaviest load which may be placed on it, and the weight of the beam (plus its load) pushes straight down on the piers.

- The load on the beam causes the upper edge of the beam to be pushed together (compression) and the lower edge to be stretched (tension).

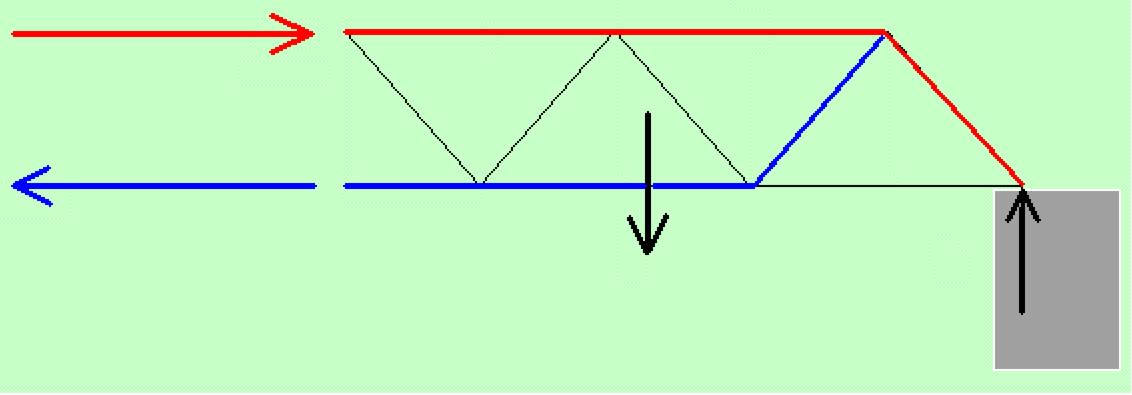


Beam Pros/Cons

- Low clearance
- Requires piers for longer spans
- Piers can be hit by ice, ships; or weakened by currents
- Inexpensive
- Relatively strong
- 200 ft per section
- Lacks appeal
- Steel, concrete, wood

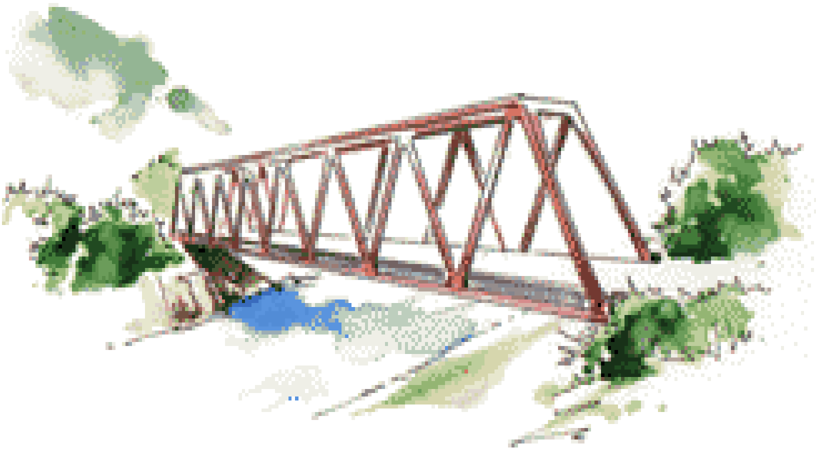
Design 2: Truss

- A truss has the ability to dissipate a load through the truss work. The design of a truss, which is usually a variant of a triangle, creates both a very rigid structure and one that transfers the load from a single point to a considerably wider area.



Truss Supports

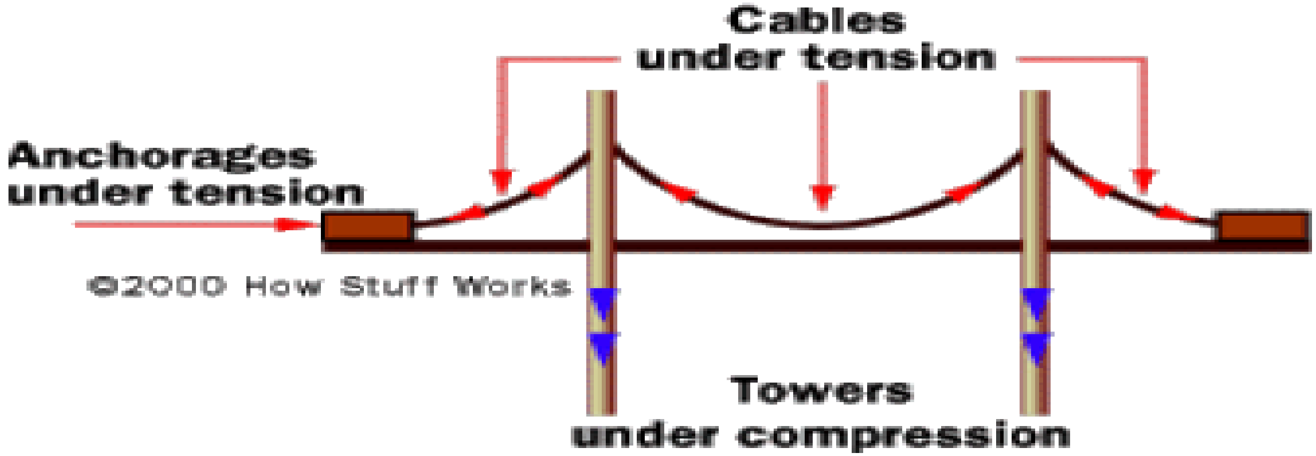
- Triangles. The triangle shape has excellent ability to dissipate force. The force is not concentrated on a single point of the beam, but is distributed throughout the structure.
- By using trusses, engineers can achieve the same strength of a bridge with a much heavier beam. A truss bridge's lighter weight reduces the dead load the bridge must support.



Truss Pros/Cons

- 200-800 ft per section
- Light
- Strong
- Expensive to maintain to prevent rust, corrosion
- Steel, wood (covered bridges)
- Can be attractive
- Low clearance, often needs draw/swing open

Design 3: Suspension



•suspends the deck from huge main cables, which extend from one end of the bridge to the other.
•cables rest on top of high towers and have to be securely anchored into the bank at either end of the bridge.
The towers enable the main cables to be draped over long distances.
• Most of the weight or load of the bridge is transferred by the cables to the anchorage systems. These are imbedded in either solid rock or huge concrete blocks.

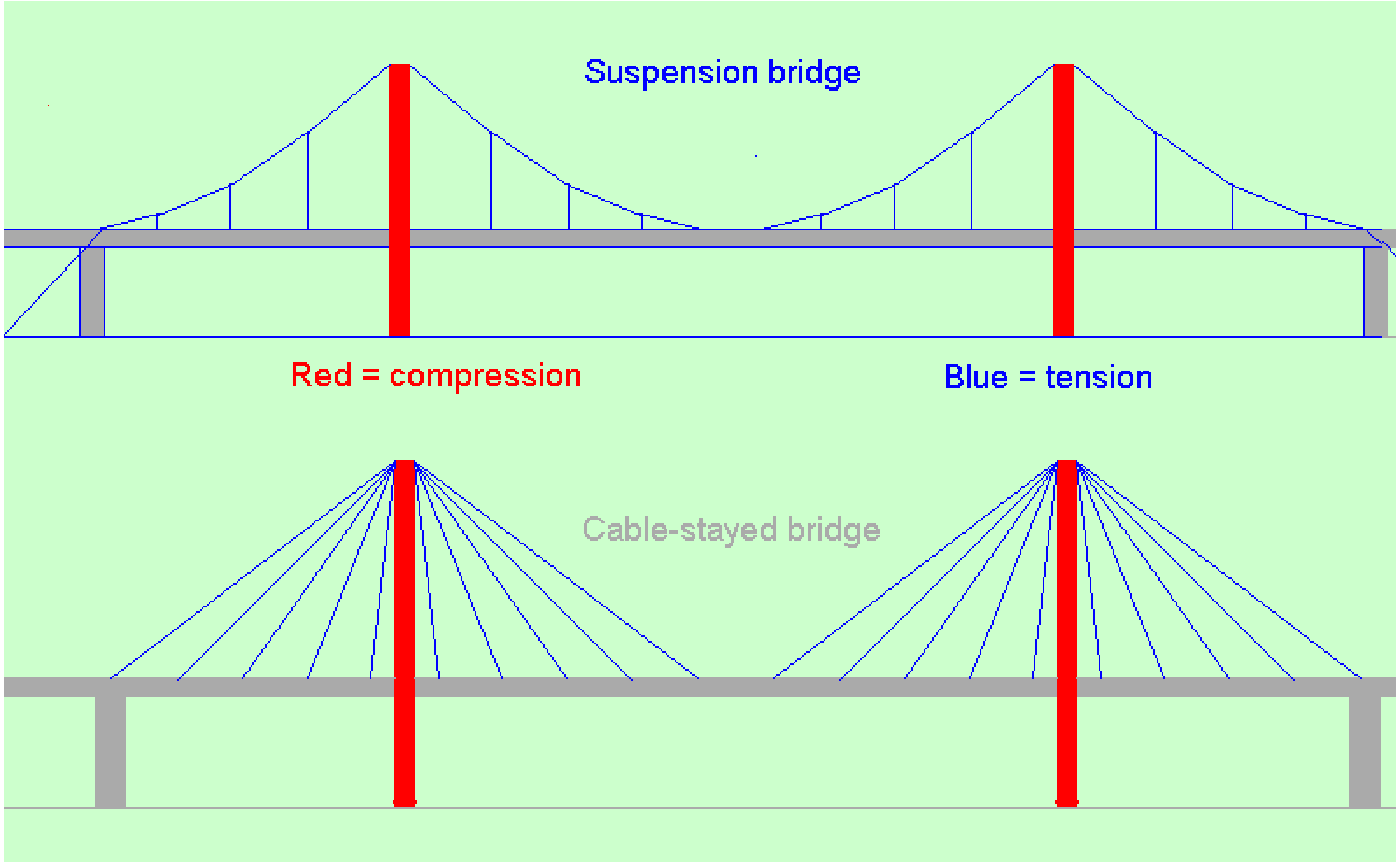
Suspension Pros/Cons

- Longest >7,000 ft
- Most expensive
- Dramatic and very appealing
- Suspension requires large anchors
- Heavy steel cables, steel towers
- High clearance for boat traffic
- Wide clearance for boat traffic

Design 4: Cable-Stay Bridges

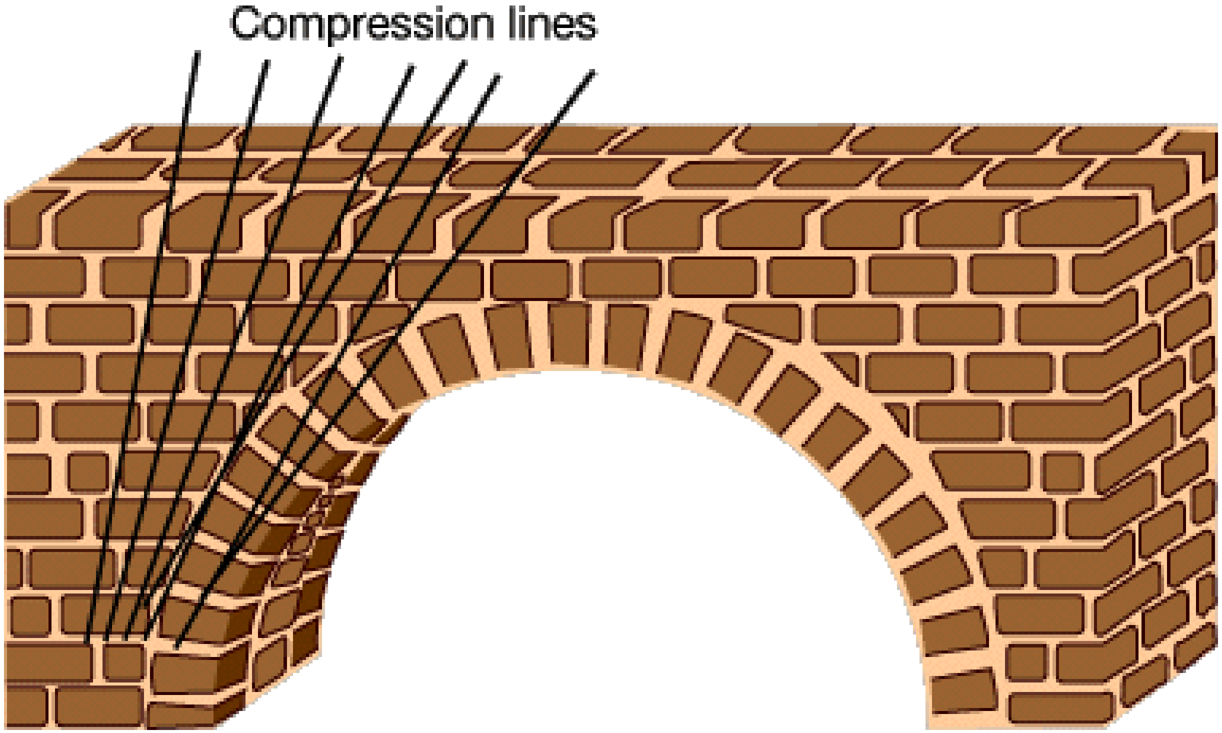
- No anchors
- Each tower supports one section
- Multiple sections can be linked together
- Expensive
- Modern, eye-catching design

Cable-Stay vs Suspension



Design 5: Arch

The load of an arch bridge is carried outward along the curve of the arch to the supports at each end. The weight is transferred to the supports at either end

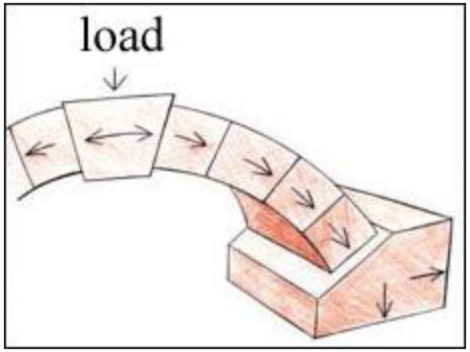


Arch Pros/Cons

- Very appealing & dramatic
- Strong
- 800-1,000 ft long
- Stone, concrete, steel, or wood
- Needs large abutments or mountains
- High clearance for floods, boats
- Historical design

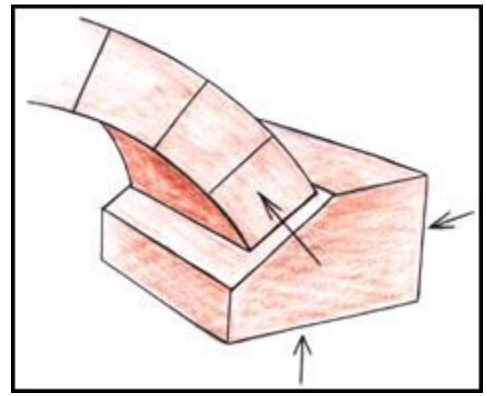
Abutments in Arch Bridges

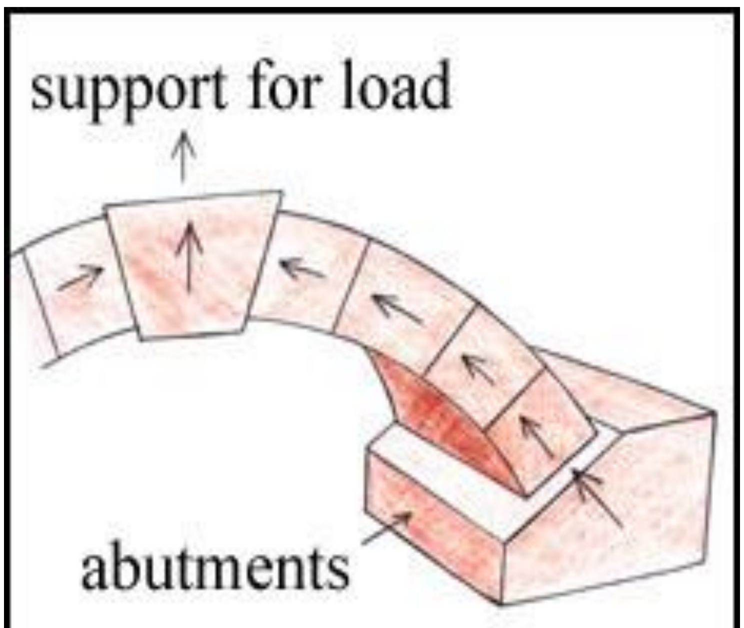
- Large abutments needed
- Often placed in mountainous areas



The load at the top of the key stone makes each stone on the arch of the bridge press on the one next to it. This happens until the push is applied to the end supports or *abutments,* which are embedded in the ground.

The ground around the abutments is squeezed and pushes back on the abutments





For every action there is an equal and opposite reaction. The ground which pushes back on the *abutments* creates a *resistance* which is passed from stone to stone, until it is eventually pushing on the key stone which is supporting the load.

7 Environmental Factors

- Obstacles
- Earthquakes
- Climate/Weather (wind, precipitation, ice, heat-cooling, storms)
- Topography (mountains, land, soil)
- Development (urban, suburban, rural)
- Appearance
- Live/Dynamic Loads (rush hour, frequency)

Case Study:

What 2 bridge designs do you see? Why did the engineer use two different designs? Was cost a factor? Appearance? What environmental factors were taken into consideration? What is the purpose/function of the bridge?